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Superorbital variability of X-ray and radio emission of Cyg X-1 - II. Dependence of the orbital modulation and spectral hardness on the superorbital phase

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Abstract

We discover a pronounced dependence of the strength of the soft X-ray orbital modulation and the spectral hardness in Cyg X-1 in the hard state on its superorbital phase. We find, our results can be well modelled as a combination of two effects: the precession of the accretion disc (which appears to cause the superorbital flux modulation) and the orbital-phase dependent X-ray absorption in an accretion bulge, located at the accretion disc edge close to the supergiant companion but displaced from the line connecting the stars by about 25°. Our findings are supported by the distribution of the X-ray dips showing concentration towards zero superorbital phase, which corresponds to the bulge passing through the line of sight. We Fourier analyse our model, and find it explains the previous finding of asymmetric beat (between the orbital and superorbital modulations) frequencies in the observed power spectrum, provided the disc precession is prograde. On the other hand, we find no statistically significant changes of the orbital modulation with the superorbital phase in the 15-GHz radio data. This absence is consistent with the radio being emitted by a jet in the system, in which case the orbital modulation is caused by wind absorption far away from the disc. We also find that both the X-ray and radio fluxes of Cyg X-1 in the hard state on time-scales $\gtrsim 104$s have lognormal distributions, which complements a previous finding of a lognormal flux distribution in the hard state on ~1-s time-scales. We point out that the lognormal character of the flux distribution requires that flux logarithms rather than fluxes themselves should be used for averaging and error analysis. We also provide a correct formula for the uncertainty of rms of a light curve for the case when the uncertainty is higher than the measurement. © 2008 RAS.

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Keywords

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